Space Weather Technical Forecast

Issued on Wednesday, 20 July 2022 at 13:14 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1/Minor Storms likely with CH02 and CH01 fast wind arrivals, most likely day 3 (22nd). Chance of M-flares (R1-R2 Radio blackouts). Chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours. There are currently nine sunspots regions on the visible disc. None of the regions have been significantly active, with only low energy C-class flares observed. The only growth observed was in two newly numbered sunspot regions AR3063 and AR3064 in the northeast quadrant. There are no Earth-directed CMEs.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 was indicative of a CME arrival, perhaps alongside a weak fast wind enhancement from CH03 (no longer visible on disc). Solar wind speeds were slightly elevated, peaking at 480km/s at 19/1500UTC, with a steady declining trend. Initially above average density fell below average after 19/1400 UTC. The IMF (interplanetary magnetic field) Bt has been steady and moderate at around +10 nT throughout much of the period, with a gradually weakening, with the IMF around +8 nT at present. The all important north-south component (Bz) was persistently negative at -10 nT at the start of the period, becoming mostly positive from 19/2130UTC, varying between -6 nT to +7 nT. This magnetic structure was indicative of a passing magnetic cloud. The phi angle was variable, but became mostly positive (towards the Sun) from 20/0030UTC. Geomagnetic activity was Unsettled to Active with one G1/Minor Storm interval (19/1200-1500 UTC), recently becoming Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at background levels. High energy electron flux was initially Low, but increased Moderate to High from 19/2130UTC, with a peak of 1090 pfu at 20/0500UTC, reducing to background by 20/0200UTC. Electron flux has recently increased from Moderate to High at present, peaking around 1130 pfu. The 24-hour integrated electron fluence was below the Active threshold (1e8 integrated pfu), falling to 7.27e6 at 20/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, with a chance of rising to Moderate from any M-flares that occur due to the number of sunspot regions on the visible disc.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Current elevated solar winds are expected to ease day 1 (20th) and day 2 (21st) before a further enhancement is possible later on day 2, but more likely on day 3 (22nd). This is due to the arrival of fast winds from CH02/- and CH01/-. Geomagnetic activity will be initially Quiet, with isolated Unsettled later day 1 (20th). Increasing to Unsettled to Active with isolated G1/Minor Storm intervals likely, with the arrival of the fast wind, either late on day 2 (21st) or more likely on day 3 (22nd). Activity easing back to Quiet to Unsettled on day 4 (23rd).

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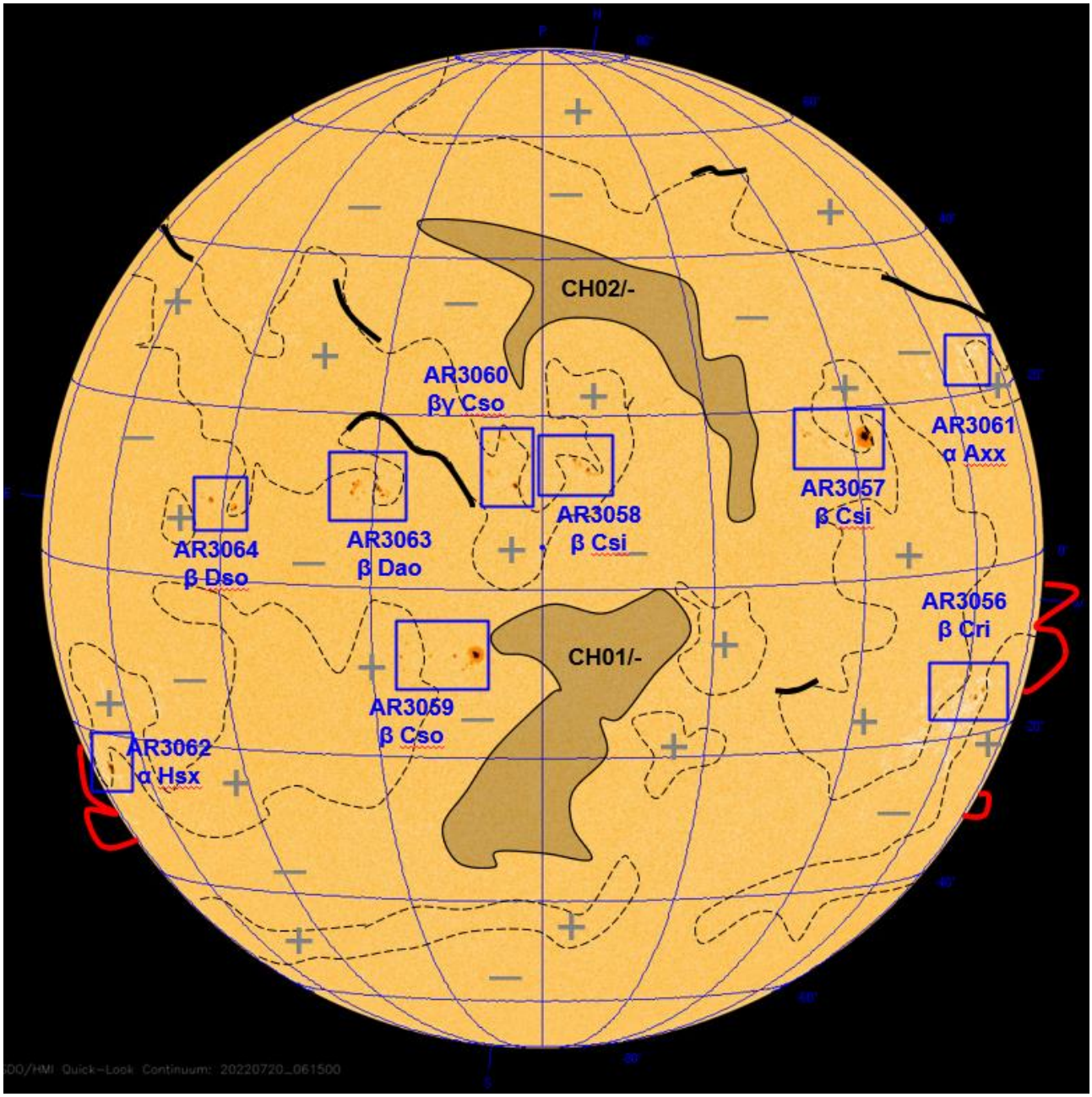
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at background levels. The high energy electron flux (greater than 2 MeV) is forecast to continue rising as solar winds ease, due to the recent enhancement with Moderate to High levels likely, before dropping out with any fast wind arrival late on day 2 or day 3 (21st or 22nd). Flux levels rising again day 4 (24th). The associated fluence is likely to rise to Active late on day 1 or day 2 (20th or 21st), easing day 3 (22nd), before rising again day 4 (23rd).

Figure 1. Solar Analysis Valid 20/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no further CME arrivals expected at Earth. The current slightly elevated solar winds are expected to gradually ease day 1 (20th) as recent CME and fast wind influence subsides. The next notable enhancement will likely be the arrival of the fast wind of CH02/-, followed by CH01/-. These two features appear more intense and have extended both equator-ward and eastward compared to the previous rotation. Consequently arrival is anticipated earlier than persistence indicates, most likely late on day 2 (21st) or day 3 (22nd). This is supported by MOSWOC Enlil, which suggests peak solar winds speeds, up to 550-600km/s, on the 22nd, although this does transition into the fast wind earlier than is expected.

Geomagnetic activity is forecast to be Quiet, with isolated Unsettled intervals later on day 1 (20th). Increasing to Unsettled to Active with isolated G1/Minor Storm intervals likely with the arrival of the coronal hole fast wind, either late on day 2 (21st) or more likely day 3 (22nd). Activity easing back to Quiet to Unsettled day 4 (23rd).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	5	30	60	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Observed solar wind parameters at L1, show the gradual waning effects of the CME, which arrived at Earth on 19th July.

Figure 3: Solar Wind Persistent Model, shows enhancement on the 23rd July on previous rotation.

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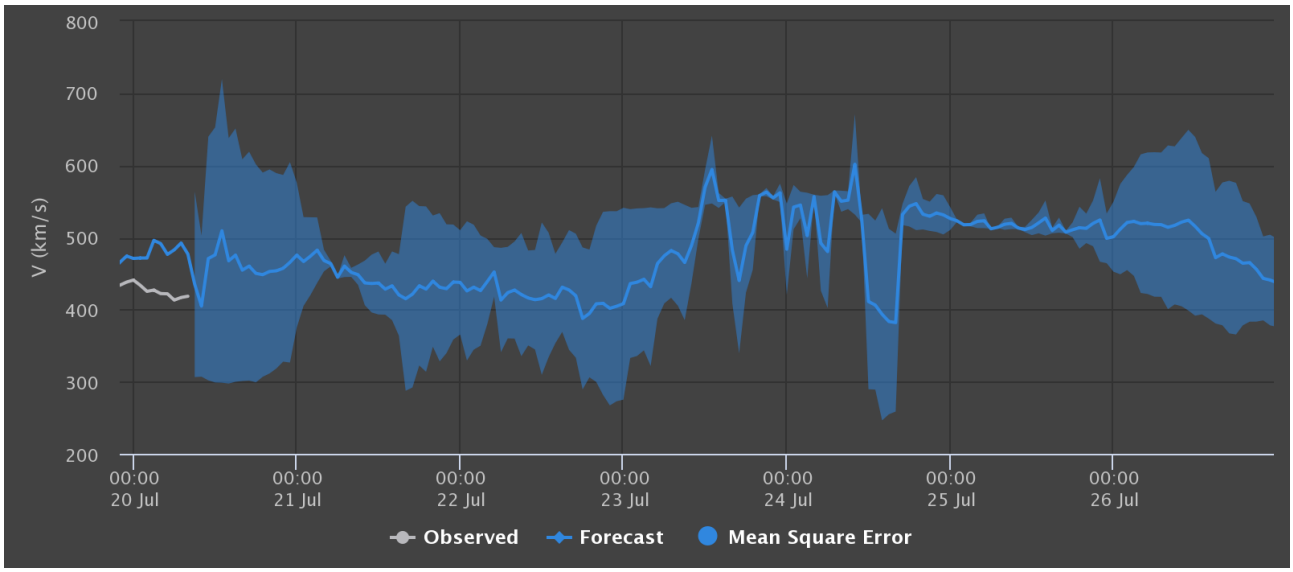
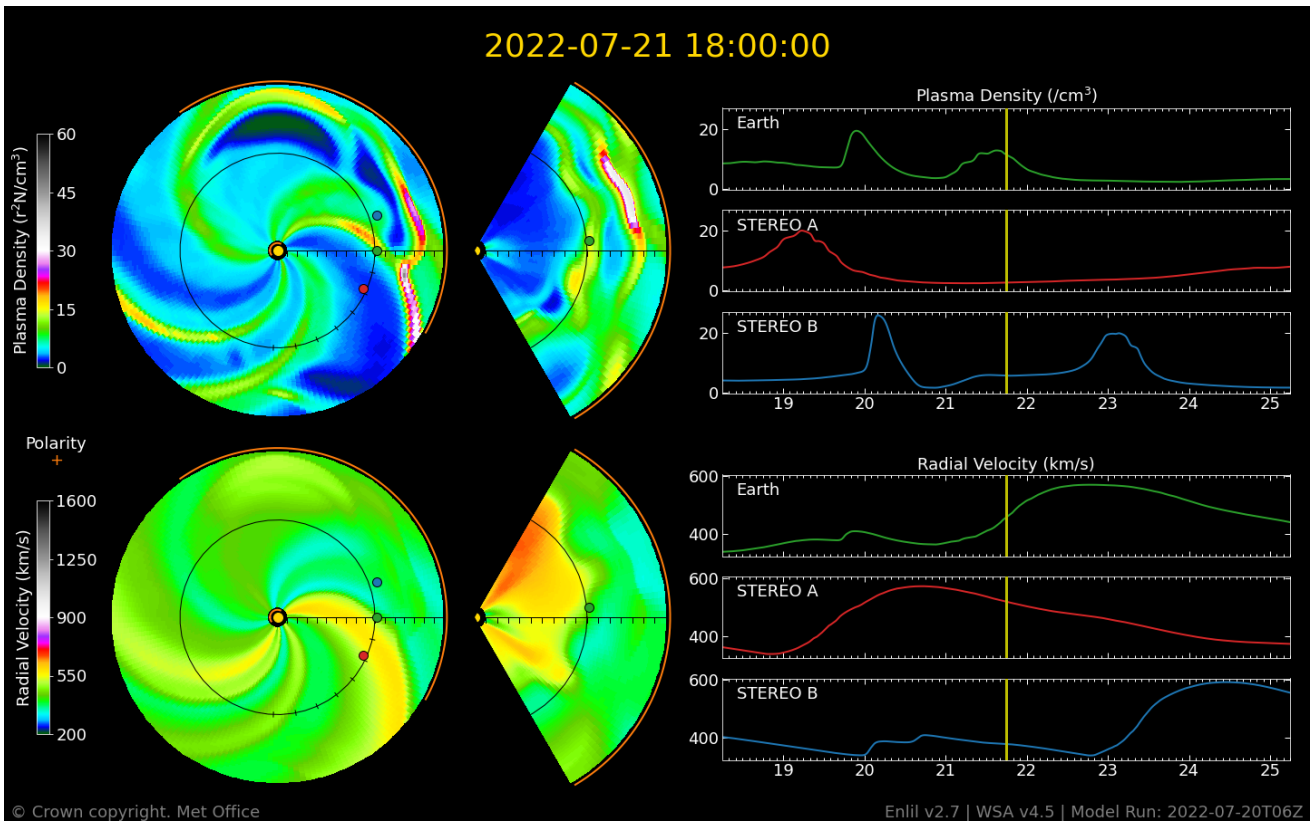


Figure 4: MOSWOC Enlil shows the arrival of CH fast winds late on 21st and most likely on the 22nd.



Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with the observed X-ray flux by GOES persisting at around C-class, with a number of small C1/C2 flares occurring. There are currently nine numbered sunspot regions on the visible disc. However, these are generally all small and either decaying or exhibiting little growth. The main flare activity appears to be from AR3056 Cri/Beta in the southwest. The only growth is currently being observed in the two new regions, which have emerged in the northeast, these are AR3064 and AR3063. With the large number of sunspots on the disc, Low activity is expected to be maintained through the period, with an ongoing chance of isolated M-flares increasing this to Moderate.

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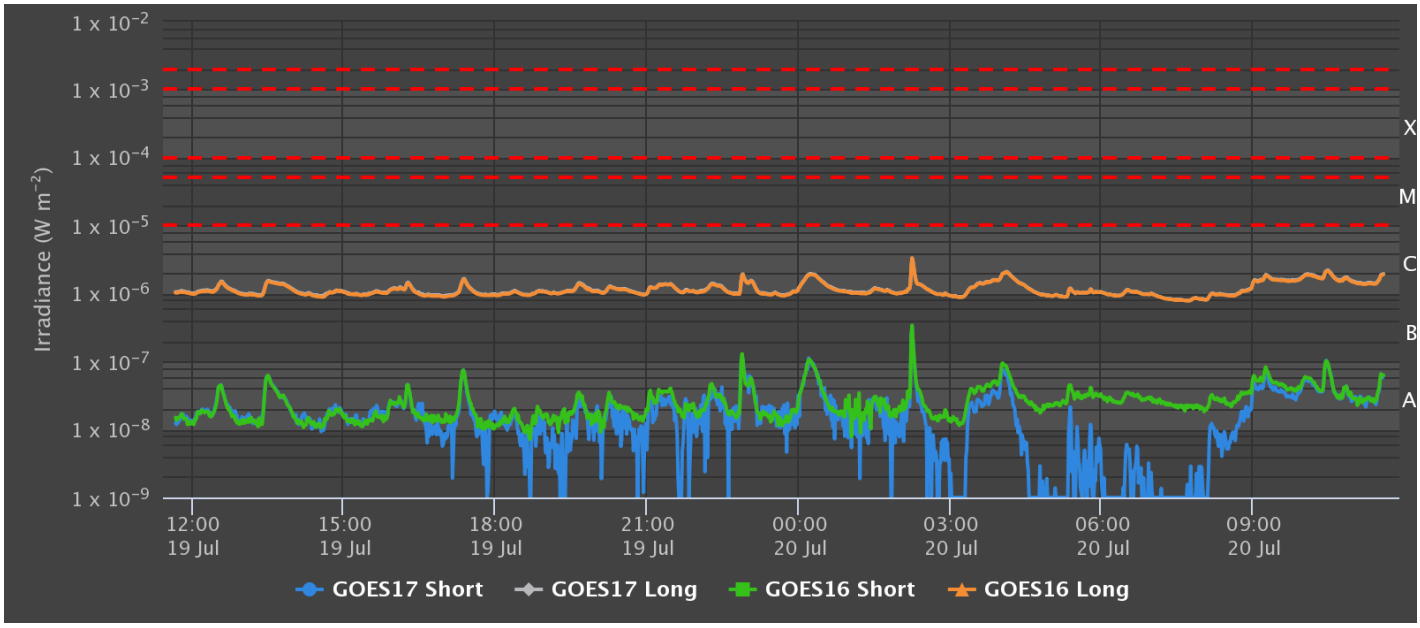
X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	25	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 5: GOES 16-17 X-Ray Flux – shows only background C-class flares.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. There is the potential for proton flux increasing due to the number of sunspot regions on the Earth-facing disc, including regions on or just over the west limb. However, these only give a very slight chance of proton flux reaching the S1 level (10 pfu).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux as measured by GOES-16 has been mostly at background due to the recent CME and fast wind arrival, but has recovered to Moderate to High as solar winds have eased. Further diurnal rises are possible during days 1 and 2 (20th and 21st), before the arrival of the next fast wind enhancement, Moderate to High levels are likely to be observed and exceeding the alert level at times (1000 pfu). A further dropout is then likely either late day 2 or day 3 with the onset of this next fast wind enhancement, however this fast wind is subsequently also likely to also enhance electron flux populations in the Van Allen Belts, with high flux returning through day 4 (23rd).

The associated 24 hour fluence is currently below the Active threshold, but likely to rise day 1 (20th) approaching the Active threshold, likely later in the day, and through day 2 (21st). This risk recedes with the onset of the fast winds of CH02 and CH01 and any subsequent dropout, before likely returning day 4 (23rd). REFM is giving poor guidance, as this is likely not accounting for the recent observed solar wind enhancement.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	40	50	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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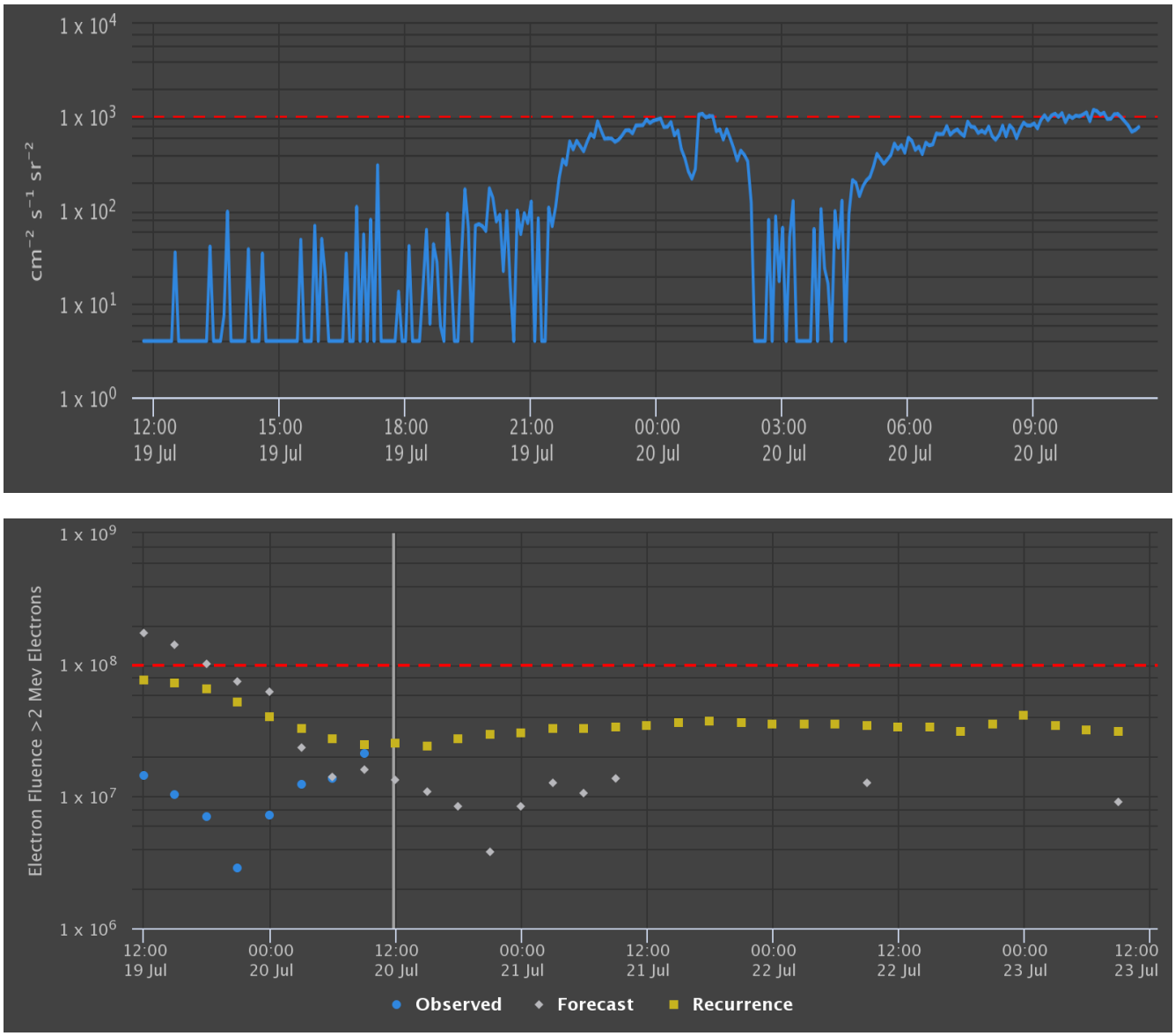
Figure 6: GOES-16 Electron Flux (top) and Electron Fluence with REFM (bottom).



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